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(56) Documents Cited:
GB 2392190 A **GB 2344369 A**
WO 2002/099173 A1 **US 6065963 A**
US 20030213485 A1 **US 20030134247 A1**

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INT CL⁷ **D04B, E01C, F23D**
Other: **ONLINE:WPI,PAJ,EPODOC**

(54) Abstract Title: **Road heater system**

(57) The road heater system, primarily for use in the repair of roads using Hot In-Place Recycling (HIR) techniques, comprises one or more panels 1-4 carrying a burner assembly that comprises a knitted metal fabric to which are supplied a pre-mixture of combustible gases and air. The knitted fabric is preferably an iron chromium alloy that includes Chromium, Aluminium, Yttrium and Zirconium. The gas/air pre-mixture is preferably supplied to the burners by a fan mix or atmospheric venturi system 8-11 with the gas preferably being Liquid Petroleum Gas. The gas supply is preferably delivered by a horizontal slide clip liquid delivery cylinder which two such cylinders preferably being mounted on the upper body of the heater assembly. The system preferably comprises four panels or cassettes which can be independently powered and which each have their own ignition, pilot and monitoring system. Also claimed is a single vehicle road repair system where the heating system is mounted on a vehicle, which may be a tractor backhoe or a wheeled or skid-steer loader.

FIGURE 1

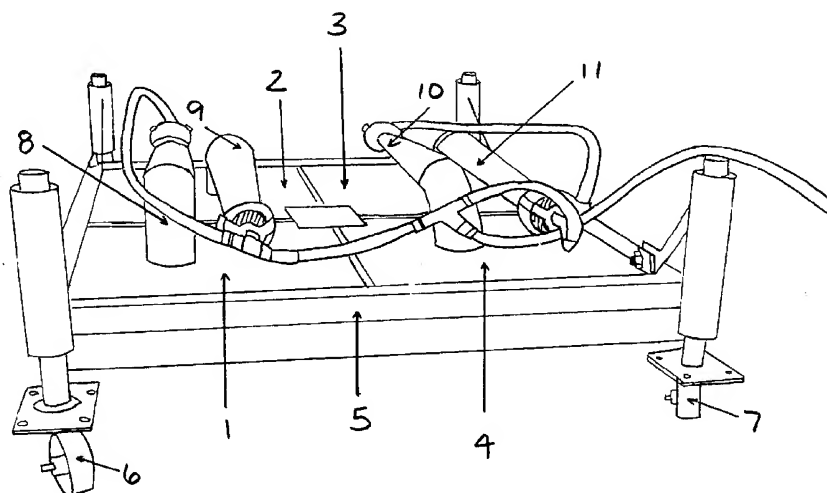


FIGURE 1

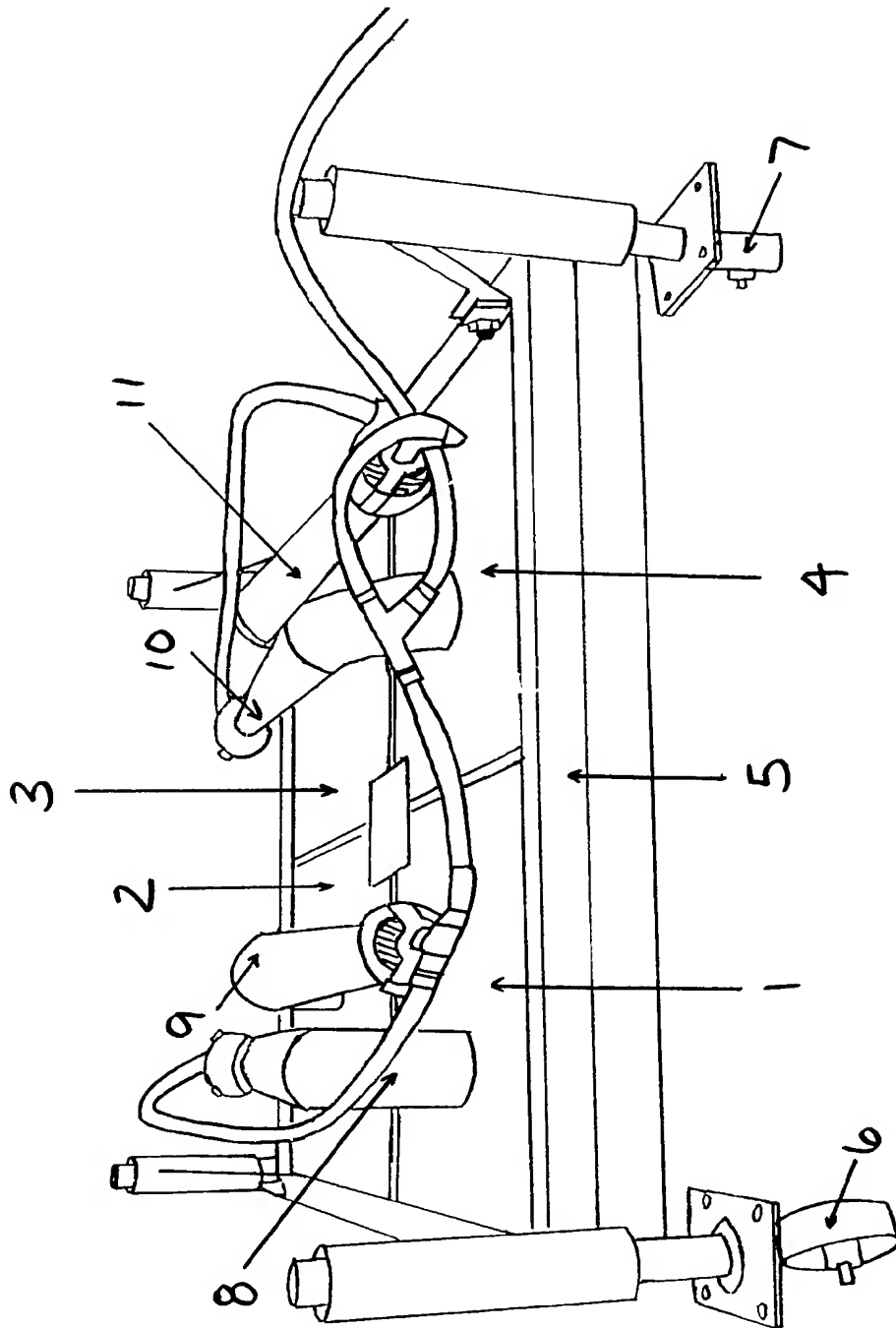


FIGURE 2

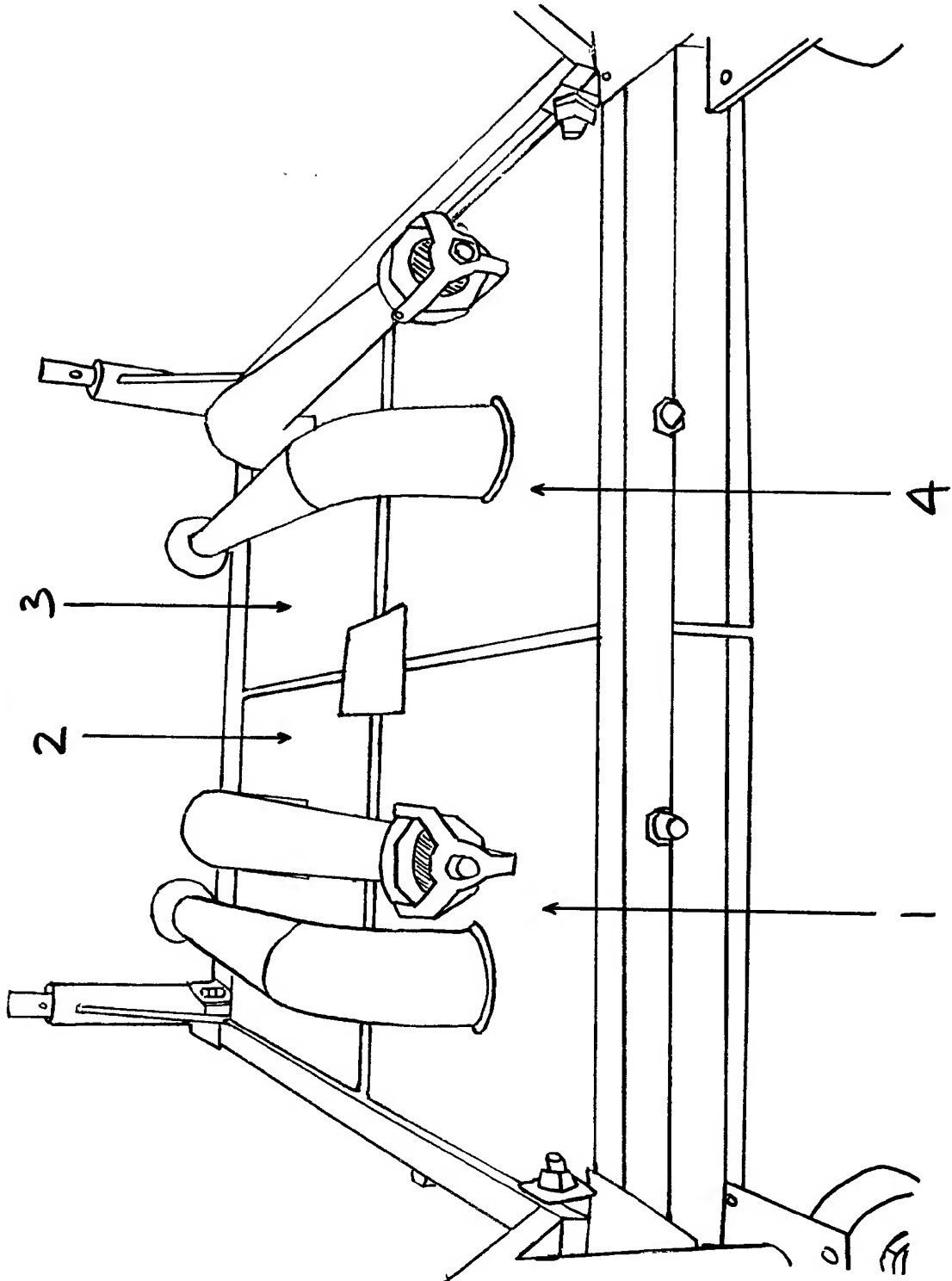


FIGURE 3

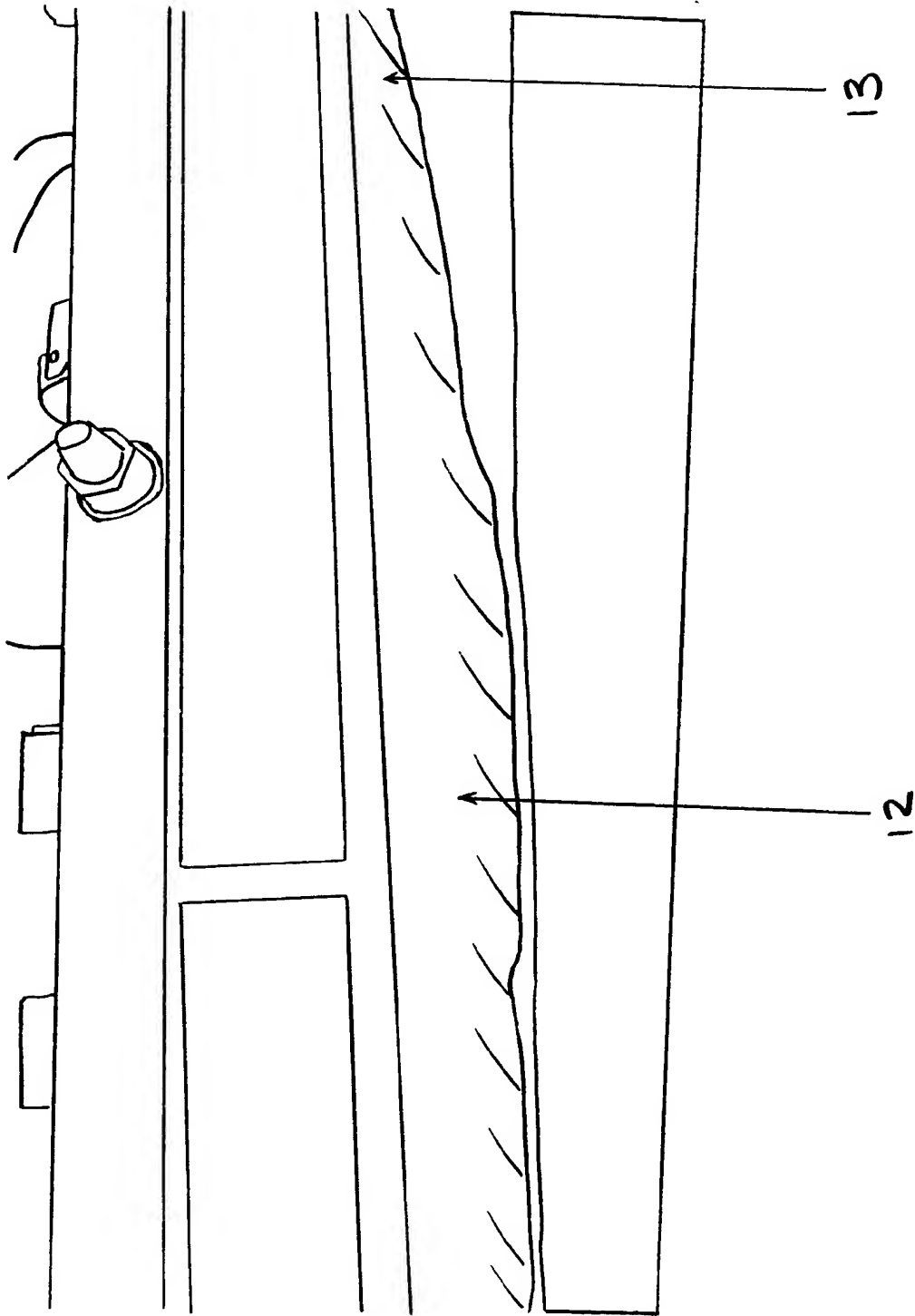
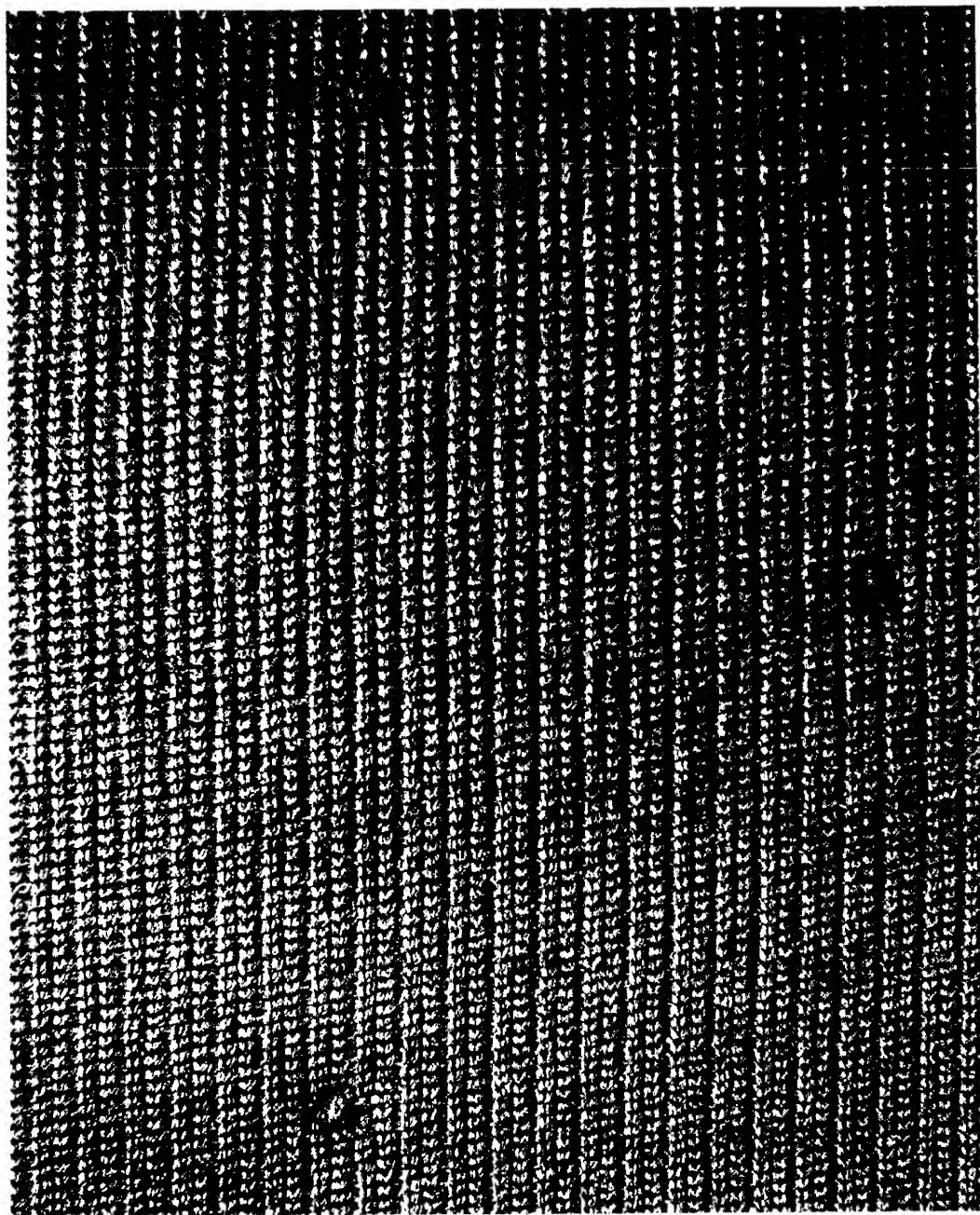


FIGURE 4



IMPROVED ROAD REPAIR SYSTEMS

The present invention relates to asphalt repair systems and in particular to systems useful in the repair of roads.

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Asphalt deteriorates because of oxidation and the constant pounding of traffic, but it is the joints from old repairs that become the Achilles heel as weather and water ingress and break up the seal and adjacent asphalt. Considerable sums of money are spent each year on routine maintenance and repair of carriages and footways, and the utility companies also spend large sums making effective repairs after their excavations. Furthermore, roads are generally deteriorating.

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Bituminous wearing courses such as asphalt are generally composed of about 94% aggregate (gravel or sand) and about 6% bitumen binder. The bitumen binder is composed of hydrocarbons and has ionic properties, which serve to bind the sand and gravel particles together.

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Wearing courses deteriorate through oxidation of the bituminous binder. The oxidation process reduces the ionic properties of the bitumen, which in turn leads to release of the aggregate. The oxidised binder loses its flexibility and the surface shrinks and cracks. The effects of traffic and weather (temperature changes and moisture) speed up this process. After general release of material larger flaws appear which eventually turn into potholes.

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The oxidation process accelerates other damage to the wearing course and failure of joints especially from conventional reinstatements, around ironwork and on trenchwork.

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The traditional method for the repair of damaged or aged asphalt and tarmacadam-wearing courses comprises the total removal of an area and its replacement with new asphalt. The damaged area and its surrounds may be removed by using noisy pneumatic or hydraulic hand held or machine mounted breakers. In this traditional method it is necessary to use expensive and very noisy diamond saws to pre-cut the area to minimise additional damage and to form a face to bond in the replacement material. The areas may also be removed by more modern methods known as cold planing that pulverizes the damaged asphalt.

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The area is then filled with new material that then needs to be compacted and sealed with overbanding or jointing sealant. The removed asphalt is then transported away for disposal that is normally for land-fill due to the limitations of current re-cycling systems.

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These conventional methods are not ideal in respect of costs, safety, environment, sustainability and durability. Such methods are described in United States Patent 4534674 and German Patent application 3906352 A1.

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More recently Hot In-Place Recycling (HIR) techniques have been developed for the effective repair of potholes, cracks and sunken utility cuts in asphalt surfaces using an infrared heating process. With the surface heated and raked it is then combined with a rejuvenation liquid that will recycle the existing embrittled asphalt. This enables a substantial reduction in repair costs. A typical rejuvenating liquid for use in the method generally comprises maltenes.

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The Infrared HIR method comprises heating the damaged area with an infrared heating device; adding new material if required; raking together; applying a liquid that rejuvenates the original bitumen; and compacting the new combined material.

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The HIR method can also include applying a topcoating liquid to the repaired area that seals and binds the repair, or applying a fine aggregate to provide skid resistance.

In our Patent Application PCT EP 0309144 we describe an improved system for the repair of roads using a vehicle mounted infra red heating system. The present invention relates to improvements to such a system.

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The present invention therefore provides an improved road heater system which can be used for the repair of roads.

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The improved road heater system comprises one or more panels carrying a burner assembly to which are supplied a pre-mixture of combustible gas and air. The burner assembly preferably comprises a knitted metal fabric. The preferred fibers for these materials are produced from an alloy known as Fecralloy, which is an iron chromium alloy of preferred composition. Fe72.8/Cr22/Al 5/Y 0.1/Zr 0.1 and has excellent resistance to oxidation at elevated temperatures. Fecralloy fibers are knitted to form a 'mat' known as NIT which preferably covers the whole burner surface and edges of the panels or cassettes. As the NIT material expands under heat, the mat is welded at specific points across its surface to ensure a consistent output whilst in operation.

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This knitted product is made from a yarn made from the Fecralloy (stainless steel alloy) metal fibres and is both flexible and durable. Although other materials may be used to

produce infrared flame Ferroalloy is preferred due to durability, consistent performance and long life capability of NIT. Radiation from the surface of the panels originates from two sources: emissions from the heated surface and emissions from the hot combustion gases leaving the surface.

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The gas/air pre-mixture is preferably supplied to the burners by a fan mix or atmospheric venturi system to enhance combustion at each of the panels. The use of the venturi system provides a balanced gas feed to the injector, with use of optimum the air supply. The venturi also provides the ability to generate a turbulent air/gas mixture to stabilize combustion on the
10 Ferroalloy NIT material which is particularly useful when repairing roads under adverse weather conditions.

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The gas supply may be from a variety of products with Liquid Petroleum Gas (LPG) providing the ideal but not exclusive source. The LPG may be either Propane, or Butane or
15 a combination of similar products. The gas supply can be delivered by conventional upright LPG gas cylinders, or preferably by a horizontal side clip liquid delivery cylinder which is particularly useful when used in combination within a purpose designed vaporizer system. If the LPG is provided by conventional vertically mounted gas delivery cylinders the volumes of gas required for this application can cause rapid freezing and this limits the operating
20 temperatures. This can also substantially limit the amount of LPG delivered from the total bottle capacity. By using vaporisers from a liquid delivery system operating ambients can be very low indeed and by extracting liquid from the cylinders it is positive to totally deplete the cylinder capacity. Thus improving the efficiency of the operation.

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In a preferred design a vaporizer assembly and manifold are fed from two horizontally mounted liquid delivery cylinders mounted in the upper body of the heater assembly. By using liquid delivery systems extended operating periods can be achieved when compared to 'normal' gas delivery methods. The vaporizer assembly is preferably made from stainless steel. A preferred assembly of the present invention comprises of 4 panels or cassettes
30 forming the center core of the infrared heater. Preferably the design of the control system, allowing for any or all of the panels to be powered. In a further preferment each panel is designed with its own ignition, pilot and monitoring system.

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In operation the premixed air gas mixture is ignited on the NIT material surface with the injectors and venturi providing an optimum mix to generate an infrared emission of medium to long wave output directly on the surface of the NIT. This can be calculated on preset output to provide optimum infrared output to soften the asphaltic surfaces to be repaired

without carbonizing the surface. The ignition can be activated by an initial spark generator powered from a transformer converting 12 volt to 110Volt to a pilot system that both carries the flame ioniser and activates the valve sequence that allows gas to be supplied to the required panel or panels.

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Infrared penetration from medium to long wave can be selected by height of the assembly from the road surface and the operating time to achieve the required depth of operation.

The dimensions of each heater panel can be selected accordingly to the intended use.

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However, we prefer to use rectangular or square panels having sides of from 300mm to 1500mm particularly from 500mm to 1000mm. In a preferred system 4 panels are used each is 500mm x 500mm to form a center core measurement of 1 meter x 1 meter. Alternatively two panels each being 1000mm x 500 may be used to form a core of 1 metre x 1 meter. Fewer panels can be preferred since it reduces the number of valves and control functions

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required. However, the burner deck design and the NIT construction places no limit to the size of panels "Wings" can be added to the outer edges to form a combination that can generate a larger heating surface area . Any combinations of the preferred 2 or 4 panel system optionally with the outer wings can be activated to form a "patchwork pattern". The metal fibre burner mainly consists of a steel housing with the metal fibre medium mounted on top. Distribution plates fed by a venturi system are used inside the housing to provide for the homogeneity of the combustion.

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The assembly can easily be extended by adding an additional number of panels or cassettes fixed on one or more sides of the assembly as may be required according to the width of the surface to be repaired. The addition of these wings is simplistic in its mechanical design allowing for a range of other width and depth options and ultimate burner configuration.

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The heating system of the present invention may be used to provide improved equipment for performing the Infrared HIR techniques described above. Accordingly, in a further embodiment the invention provides a single vehicle road repair system wherein the means for supplying infrared heat to the surface to be repaired, is the system of the present invention combined with means for storing and supplying hot new asphalt, means for storing and supplying a rejuvenation liquid, and means for storage and supply of gas for heating.

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The vehicle may be a truck, fitted at the rear with an infrared heater system according to the present invention, in a preferred embodiment the heater system is adapted to be moved

towards and away from the surface to be repaired. The vehicle could be provided with a hot box that contains replacement asphalt if required, an adjacent tank containing rejuvenation liquid which may use the hotbox residual heat to maintain a good working temperature, and preferably a pump and lance for delivery of the liquid to the desired location. In a preferred embodiment a small waste container may be provided. A secure area is preferably provided for hand tools and other equipment such as traffic control signs, rakes and other equipment. A tow bar may be fitted for towing a trailer-mounted compaction roller.

In another embodiment the vehicle may be a tractor backhoe or wheeled or skid-steer loader to which the equipment may be quickly installed or removed. The attachment that forms the infrared heater of the present invention may be fixed to the dipper arm (of a backhoe loader) or the front loader quick change system (of a skid steer) so that it may be moved towards and away from the surface to be repaired. A separate attachment may be fitted to the rear of the vehicle containing a hot box for new asphalt, an adjoining tank for rejuvenation liquid that uses the hotbox residual heat to maintain a good working temperature, and a spray lance for its application to the raked area. With this system the area to be repaired may be heated with the vehicle which is then moved quickly away to a suitable position, the heated area is then raked so that the rejuvenating liquid may be delivered to the prepared surface of the area being repaired, prior to compaction.

Such attachments for tractor backhoe vehicles are a part of the present invention.

The invention therefore provides more efficient, compact and lightweight equipment that enables faster, quieter and more economic method of repair of a wearing course using HIR techniques.

The heating of the damaged area to be repaired may be carried out using the heaters of the present invention tailored to suit the size and shape of the area to be repaired. Typically the heating needs may be to depths of 10 mm to 100 mm from the surface. The average temperature of the heated material should generally not exceed 200°C and may be from 50 to 200°C, preferably 100 to 200°C. As with all carbon structures heat increases oxidation, but since the infrared output of the infrared attachment is selective at its medium wave output it does not induce burning (which would destroy the binder's asphaltenes permanently) The heating time may vary according to its structure and dependant upon the surface temperature, wind chill factor and whether the surface is damp, but may for example be from 5 to 20 minutes, typically 6 to 8 minutes.

Once heated, the damaged area may be raked or scarified to mix the highly oxidised top surface with the less oxidised sub-strata. This also increases the surface area of the mix. Care must be taken to leave an outer perimeter of the heated area unraked to allow development of an efficient bonded joint when compacted.

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A rejuvenating liquid may then be applied preferably using a lance provided on the vehicle. Typically the composition of the rejuvenating liquid comprises rejuvenating oils high in aromatics with high levels of polar compounds. The oils in the rejuvenating liquid are preferably emulsified with cationic slow set emulsifiers at higher than normal levels to ensure not only a very storable and stable emulsion but also to aid in a slow cure and break time.

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The rejuvenating liquid preferably contains from 30 to 80 parts by weight in total of a heavy paraffin distillation solvent extract and a heavy naphthenic distillate solvent extract, from 10 to 60 parts by weight of water, and from 1 to 5 parts by weight of the emulsifier. More preferably, the liquid comprises from 60 to 65 parts by weight in total of the heavy paraffinic distillate solvent extract and the heavy naphthenic distillate solvent extract, from 30 to 35 parts by weight of water and from 1 to 5 parts by weight of the emulsifier.

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New material may be needed if it is required to level the patch to be repaired, i.e., the amount of material that has been worn out of the surface. The material may also assist in knitting of the joint. On hot rolled asphalt, precoated chippings are added and compacted into the surface to give road texture. The material is generally raked level and then compacted either by a vibrating roller or compaction plate. A topcoat of a sealer/binder may also be applied, or a dusting of fine aggregate (e.g. aluminum silicate) may be added to ensure good initial skid resistance. Once the surface has cooled and hardened, normally for a minimum of one hour, it is capable of accepting traffic. The benefits of the system of the present invention are that they have a long operating life and are extremely safe in use due to it being flashback-, splash- and shock-resistant and their ability to withstand very high temperatures. The flexible burner design has excellent control capabilities and single NOX and CO ratings. Combustion and infrared emissions are unaffected by moisture, accidental fuel spillage or mechanical stress. In addition the burner systems of the present invention provided efficient fuel utilization and fast heat up and cool down properties.

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The advantages to using the road repair apparatus of the present invention over traditional methods are:

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1. Reduced asphalt costs since only material lost as a result of the damage is added: in the conventional method it is also necessary to replace material that is removed from around

and beneath the damaged area. Substantial cost savings arise due to avoiding the need to transport the removed asphalt to land fill with its additional charges.

2. The resulting repair is fully bonded with the existing material by means of heat fusion.

5 This eliminates or reduces the problems of joint failures and the problem of 'cold shock' that occurs in the conventional method when hot sealant or new material is added to cold asphalt to join the new material to the old material. There is no pre-cutting of an edge to the old surface, no need for any kind of overbanding or joint sealing (notoriously short-lived), and no mixing of materials with different expansion and contraction rates next to each other.
10 Furthermore, when the application of the topcoating is included in the method of the invention, the surface is further bonded.

3. By recycling the existing surface there is far less new material used, the process is very quiet, and its speed enables the roads to be opened up far more quickly than would normally
15 be the case. Due to the lack of noise, roads may be repaired at night while traffic is at its lightest with less disturbance to residents.

4. This method of repair also eliminates the problems of 'white finger' caused by pneumatic and hydraulic hand held breakers, which is a major problem to the construction industry,
20 causing added costs to all concerned.

5. Some 94% of the wearing course is rock or sand and has an extremely long lifetime of many decades. Of the 6% of the wearing course that is binder, only a small fraction is degraded and the remainder (the predominant compounds being asphaltenes) has a very
25 long life span. By replacing only the fraction of the aromatic oil component that is lost, the total combined method of the invention is highly efficient in material terms, and as a result effectively recreates the hydrocarbon chain.

The invention is illustrated by reference to the accompanying drawings in which:

30 Figure 1 shows an assembly according to the present invention comprising four panels 1, 2, 3 and 4 mounted on a frame 5 provided wheels of which only two (6 and 7) are shown. The frame can be raised or lowered to adjust proximity to the road surface to be heated. Each panel is fitted with a venturi tube 8, 9, 10 and 11 for the supply of a mixture of combustible
35 gas and air (from cylinders not shown).

Figure 2 is a top elevation of the assembly shown in Figure 1 showing how the panels 1, 2, 3 and 4 are assembled.

Figure 3 is an end view of the assembly shown in Figure 1 showing the ends 12 and 13 of the Fecralloy knitted fabrics fitted to panels 1 and 2.

Figure 4 shows a Fecralloy knitted fabric a piece of which is fitted to the underside of each of the panels 1, 2, 3 and 4.

10 In the of the roads using the heater systems illustrated, the damaged area to be repaired is heated by the infrared system, the area is then raked and the pump may then be activated to deliver the rejuvenating liquid. The mix of heated original asphalt plus new material if required may then be further raked before being compacted by a vibrating roller or compaction plate. Once leveled to the original surface profile the repaired road is ready to
15 accept traffic.

CLAIMS

1. A road heater system comprises one or more panels carrying a burner assembly comprising a knitted metal fabric to which are supplied a pre-mixture of combustible gas and air.
2. A road heater system according to Claim 1 in which the knitted metal fabric is of an iron chromium alloy.
3. A road heater system according to Claim 1 in which the iron chromium alloys is of the composition Fe72.8/Cr22/Al 5/Y 0.1/Zr 0.1.
4. A road heater system according to any of the proceeding Claims in which the gas/air pre-mixture is supplied to the burners by a fan mix or atmospheric venturi system.
5. A road heater system according to any of the proceeding Claims in which the combustible gas is Liquid Petroleum Gas.
6. A road heater system according to any of the proceeding Claims in which the gas supply is delivered by a horizontal slide clip liquid delivery cylinder.
7. A road heater system according to Claim 6 in which the vaporizer assembly and manifold are fed from two horizontally mounted liquid delivery cylinders mounted in the upper body of the heater assembly.
8. A road heater system according to any of the preceding Claims comprising 4 panels or cassettes.
9. A road heater system according to any of the preceding Claims in which the control system allows for any or all of the panels to be powered.
10. A road heater system according to Claim 9 in which each panel is provided with its own ignition, pilot and monitoring system.
11. A road heater system according to any of the proceeding Claims in which the panels are rectangular or square panels having sides of from 300mm to 1500mm particularly from 500mm to 1000mm.

12. A single vehicle road repair system wherein the means for supplying infrared heat to the surface to be repaired is a road heater system of the present invention.

5 13. A single vehicle road repair system according to Claim 12 in which the vehicle is a tractor backhoe or wheeled or skid-steer loader

10 14. A single vehicle road repair system according to Claim 13 in which the infrared heater of the present invention is fixed to the dipper arm (of backhoe loader) or the front loader quick change system (of a skid steer).



Application No: GB0416244.2

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Examiner: Mr Charles Jarman

Claims searched: 1-14

Date of search: 16 November 2004

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
Y	1-5, 8-14	WO02/099173 A1 (N.V. BEKAERT S.A. ET AL) See whole document.
Y	1-5, 8-14	US2003/134247 A1 (DEWAEGHENEIRE) See e.g. paragraph 34 particularly.
Y	1-5, 8-14	US6065963 A (DEWAEGHENEIRE ET AL) See e.g. column 2, lines 37-50 particularly.
Y	1-3, 4, 5	US2003/0213485 A1 (KIESWETTER) See whole document.
Y	1-3, 5, 8-11	GB2344369 A (NUPRO LIMITED) See whole document.
Y	1, 5, 12-14	GB2392190 A (ROADS EUROPE LTD) See whole document.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^W :

E1G; F4T

Worldwide search of patent documents classified in the following areas of the IPC⁰⁷

D04B; E01C; F23D

The following online and other databases have been used in the preparation of this search report

WPI, PAJ, EPODOC